# APPLICABILITY OF THE USE OF AEROPONIC SYSTEM AND SILICON SUPPLEMENTATION ON GROWTH AND THE FLORICULTURAL QUALITY TRAITS OF *Dendrobium* sp.

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## INTRODUCTION

Floriculture industry in Sri Lanka is a profitable industry earning about 25% annual export income. *Dendrobium* sp (Orchidaceae) is the most 'in demand' cut flower in the export and local market due to its vivid and variable flower colouration. However, the production of quality flower is the major obstacle faced by local growers in Sri Lanka.

However, no research has been carried out to improve the floricultural quality and reduce diseases of Dendrobium plant/flower using non- hazardous methods. Hence, this research was focused on improving the floricultural quality of flowers using abiotic elicitor, 'Silicon'. The potential benefits of silicon nutrition in plants have been extensively studied by several scientists in the world. Some of these include the enhancement of growth and yield, improvement of mechanical properties, reduction of transpiration, resistance to metal toxicities and suppression of fungal and bacterial diseases.

The recent research findings indicates that silicon supplementation has improved the quality of Gerbera (Savvas *et al*., 2002 ), Roses (Ehret *et al*., 2005), Helianthus (Kamenidou *et al*., 2008), Sunflower and Zinnia (Kamenidou *et al* .,2008, 2009).

The present research was carried out to investigate the effects of silicon supplementation and application time on growth parameters (stem length, leaf length and number of leaves), and some floricultural quality traits of flowers (days for anthesis, number of flowers per spike, flower size, length and diameter of spike) of *Dendrobium* orchids. Practicality of growing orchid plants in newly developed aeroponics system was also tested with application of different levels of soluble silicon.

## METHODOLOGY

### Plant material

Healthy, mature, twelve month month old, tissue cultured, *Dendrobium* plants *(cv. Ckai brownderby-TDC-23*, and cv. Sonia) bought from the orchid nursary at the Department of Agriculture, National Botanical gardens, Peradeniya were used for the experiements.

Plants were planted in clay pots containing charcoal and tile pieces. These were kept in a mesh house at the Open University of SL,Nawala.The mesh house environment provided the required 50% shade by shade nets and misting was done to maintain the required temperature and high humidity levels. The recommended NPK (20: 20: 20) levels of fertilizer was provided twice weekly.

### 1. Preharvest application of Silicon supplementation

Three sets of *Dendrobium* plants, each containing 12 plants were used for this study. Silicon supplements were provided by applying sodium silicate (Sigma Aldrich inc. USA) as a foliar spray (5ml of solution as a fine mist) using a 1 L spraying bottle. One set of 12 plants were treated with sodium silicate (100 $mgL^{-1}$) at weekly intervals.The second set of 12 plants were treated with the same concentration of sodium silicate (100 $mgL^{-1}$) but applied at two week intervals.The third set of 12 plants was sprayed with water and maintained as the control.

### *1.1.Effect of silicon supplementation on growth parameters*

The growth parameters; stem length, leaf length and number of leaves were measured in *Dendrobium* plants treated with 100 mg/L Silicon at weekly and bi-weekly intervals and compared with that of control plants. The stem length was measured from the base of the plant at the soil surface to the apex or tallest point of the plant. Leaf length was measured from leaf base to apex in the third leaf. An average value for each of the above parameters was calculated per treatment every month for 14 consecutive months.

### *1.2 Effect of Silicon supplementation on flower quality traits*

Some postharvest flower quality parameters: Days for initiation of buds, flowers, number of flowers per spike, flower size, spike length, spike diameter were evaluated for the plants treated with silicon and non treated control plants by recording the measurements throughout the period..

### *1.3 Levels of silicon in silicon treated plants*

Analysis of molybdate reactive silica ($SiO_2$) by molibdosilicate method using spectrometry (Clesceri *et al.,* 1998)

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls, using spectrophotometer.

HCl (0.5 $cm^3$) and ammonium molybdate solution (1.0 $cm^3$) were added to 25.0 $cm^3$ of sample solution. The solution was mixed thoroughly and was allowed to stand for 5 – 10 minutes. Then Oxalic acid (1.0 $cm^3$) was added to the same solution and was mixed thoroughly. The absorbance of the solution was obtained at 410nm after 2 min. (before 15 min.), measuring the time from the addition of oxalic acid solution. Calibration standard solutions in the range of 4-12 ppm and the blank (distilled water) were prepared in the same manner and the absorbance was measured.

When dissolved in diluted HCl, sodium silicate forms silicic acid which is a gelatinous precipitate. The silicic acid precipitate was filtered and washed with distilled water in order to remove any $Na^+$ that might be adsorbed on to the precipitate; silicic acid was then dissolved in excess KOH to form potassium silicate.

### (2)Effect of silicon supplementation on orchids cultivated in Aeroponics system

18 month old *Dendrobium* sp. (*cv.Sonia.*)was transplanted in a aeroponics system as illustrated in Fig 01. Eight plants were put into net pots incorporating charcol pieces. Fertilizer (Standard NPK (20,20,20) was sprayed as a mist into boxes every day for a period of 05 min using pipe systems and electric pump designed as follows. Three boxes were connected to the nutrient tank and the excess nutrient solution was recycled.

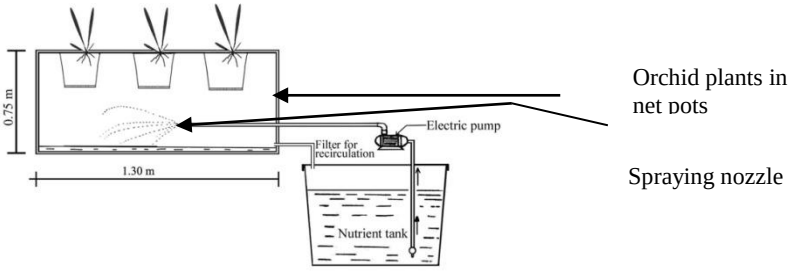


**Fig 01. Newly designed aeroponics system for cultivating Orchids**

Treatment was given at 2 week intervals. Each box contained 08 plants and plants in Box 01 was provided with 50 mg/L of sodium silicate and Box 02 with 100 mg/L of sodium silicate. Box 03 was sprayed with water (control).

## RESULTS AND DISCUSSION

### 1. Effect of silicon supplementation on growth paramenters

**Shoot length** –

All plants either weekly or biweekly treated with 100mg/L silicon showed higher shoot length compared to controlled plants. Plants treated with silicon biweeekly showed the highest value compared to plants treated weekly with silicon or non treated control. Lowest shoot length was observed in non treated control plants. A significant increase in stem height of plants treated with silicon was observed compared with the control plants. However, there was no significant difference between the stem height of plants sprayed with silicon at weekly intervals and two weeks intervals.

**Leaf length and number of leaves**-

Plants treated with silicon either weekly or biweekly showed higher leaf length and number of leaves. The highest was oberved in plants treated with silicon at weekly intervals. However, no significant difference in the values of leaf length and numer of leaves was observed in treated plants compared with the controlled plants. Silicon treament given at weekly intervals had more impact on increasing the leaf length and number of leaves of *Dendrobium* Orchids. It has been recorded by Vendrame, *et al* in 2010, that the application of $KSiO_3$ affect overall growth of *Phalaneopsis* orchid liners and increased fresh weight and dry weight of root shoot and whole plant over the controlled plants.

***Effect of Silicon supplementation on floricultural quality traits***

The lowest time was taken for intiation of buds (24 months)and flowers(25 months) in orchid plants treated with silicon at 100mg/L weeekly intervals.This was significanly different with the plants treated with silicon biweekly intervals and non treated plants with Silicon(Table 01).

There were significanly higher number of flowers (14) in a spike in plants treated with silicon at weekly intervals compared to plants provided with silicon at bi-weekly intervals (flowers in a spike -11) and in non treated controlled plants. The highest length and diameter of flowers (9 cm, 7.4 cm) was observed in the plants provided with silicon at weekly intervals compared to the plants recieved silicon biweekly (diameter of flowers-8.2 cm, 6.2 cm) or in non treated controls(diameter of flowers-8.5 cm, 6.0 cm).

Similarly, the orchid plants provided with silicon at weekly intervals have shown significantly higher length of the spikes( 63.20 cm) and diameter (3.07 cm) compared to the plants provided with silicon biweekly (spike length-58.70cm :diameter-1.97cm ) or non treated with silicon (spike length-59.16cm :diameter-1.96cm ). It can be concluded that Silicon treatment given at weekly intervals had significantly improved the floricultural quality (early bud and flower intiation, increasing the number of flowers in a spike,diameter, length of flowers, spike thickness and length) of *Dendrobium* flowers compared to the plants treated biweekly with silicon (100mg/L) or non treated control plants.

Similar observations have been recorded in sunflower and Zinnias. The diameter of sunflower was significantly increased and flowers had thick straight stems, and increased plant height when silicon was applied as sodium or pottasium silicate to the plants as root drenches or foliar spray. The basal stem diameter of ‘Zinnias’ was also increased when Potassium silicate was applied as a weekly drench at 100mg/L (Kamenidou *et al* .,2008, 2009).

Savvas *et al* in 2002 also reported that crop quality of Gerbera was increased by having thick stems and quality flowers. Similary, Kamenidou *et al*..,in 2010 also recorded that Gerbera produced thicker flower pedancles, increased flower diameter, increased height and flowered earlier when treated with sodium silicate.The silicon treated roses also possessed thick stems when treated with silicon (Ehret *et al*., 2005). All these finding are in agreement with the present study on effects of silicon on improving the floricultural quality traits of *Dendrobium* orchids.

Preharvest disease caused by *Pseudocercospora* sp was reduced by over 60% in *Dendrobium* plants treated with 100mg/L weekly intervals than the plants treated with 100mg/L Silicon at bi-weekly intervals or non treated control plants.

**Table 01. Effects of silicon supplimentation on floricultural quality traits**

| Treatments | Months for anthesis | Months for Flower initiation | No of flowers | Flower Length (cm) | Flower diameter (cm) | Spikelength (cm) | Spike thickness (cm) |
|---|---|---|---|---|---|---|---|
| silicon (100mg/L) weekly | $24^a$ | $25^a$ | $14.40^a$ | $9.00^a$ | $7.40^a$ | $63.10^a$ | $3.07^a$ |
| Silicon biweekly | $25^b$ | $26^b$ | $11.20^b$ | $8.20^b$ | $6.20^b$ | $58.70^b$ | $1.97^b$ |
| Control | $25.6^b$ | $26.6^b$ | $11.00^b$ | $8.5^b$ | $6.00^b$ | $59.16^b$ | $1.96^b$ |

Letters denoted by supercripts indicate significant difference at $P \leq 0.05$ from the Duncan Multiple Range Test.

***Levels of silicon in silicon treated plants***

The amount of silicon absorbed by the leaves and stems was analyzed in plants treated with different levels of sodium silicate and untreated controls, using spectrophotometry. However, there was no any increase of silicon levels of root or shoot or leaves observed in silicon treated plants compared to controlled plants.The analysis of silicon of plant material was done to quantify presence of molybdate reactive silica ($SiO_2$), and this form of silica may not be the silicon present in the treated plant. Therefore, results obtained from this experiment had no correlation with the silicon treated and control plant.

**2. Effect of silicon supplimentation on orchids cultivated in Aeroponics system**

*Dendrobium* cv.*Sonia* grown in the aeroponics system treated with silicon either 50mg/L or 100mg/L were shorter than the control. The lowest height was observed in the plants treated with Silicon (50 mg/L). Silicon treated plants grown in the aeroponics system showed an average higher number of flowers per spike, greater spike thickness and longer spike length compared to untreated control and plants treated with 100mg/L silicon levels.

**CONCLUSIONS AND RECOMMENDATIONS**

All 100mg/L silicon treated plants either weekly or biweekly showed higher shoot length, higher leaf length and number of leaves compared to controls. Silicon treatment given at weekly intervals had significantly improved the floricultural quality of *Dendrobium* flowers compared to the plants treated biweekly with silicon (100mg/L) or non treated control plants. Plants grown in aeroponics system and treated with 50mg/L silicon weekly showed higher floricultural quality traits.

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